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# The Effect of Pine Butterfly Defoliation on Ponderosa Pine in Southern Idaho

Progress Report
1958

by

W. E. Cole
Entomologist

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# THE EFFECT OF PINE BUTTERFLY DEFOLIATOR ON PONDEROSA PINE IN SOUTHERN IDAHO

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## SUMMARY

1. The growth trend of the 12 study trees appears to have configuration, especially during the years of defoliation.

2. The growth trend due to defoliation was not allowed to continue due to control of the pine butterfly epidemic; however, by comparing increment during the epidemic with the increment prior to and after the epidemic, defoliation of less than 25, 25-50, 75-90, and greater than 90 percent had no apparent effect; but 50-75 percent defoliation caused an apparent increase in growth.

3. Using this same method of comparison and by combining all defoliation classes, the affected trees within areas showed a slight increase in growth.

4. As a result of the 1954 control project, less than 1 percent of the total trees and less than 0.5 percent of volume have succumbed to either the direct or indirect effects of the defoliation. The uncontrolled epidemic of 1922-23 caused a loss of 26 percent of the total trees, or 36 percent of the volume.

## GENERAL

Observations from 1950 to 1952 indicated that the pine butterfly, Neophasia menapia (F. & F.) was increasing on the Boise National Forest in southern Idaho. In the summer of 1953 severe defoliation became evident in an area between Deadwood Reservoir and the Middle Fork of the Boise River (Cole, 1955). The 1953 aerial and ground surveys disclosed a total of 169,000 acres of mature, high-value ponderosa pine to be infested. In 1954, 255,403 acres were aerially sprayed resulting in a reduction of 99 percent of the pine butterfly population (U.S.F.S., 1954).

Outbreaks of the pine butterfly have occurred rather infrequently; in 1882 in the Washington Territory near what is now Spokane (Stretch, 1882), in 1893-96 on the Yakima Indian Reservation (Hopkins, 1907), in 1922-23 along the Little Salmon-Payette Rivers in Idaho (Evenden, 1926), and during 1953-54 in the Boise National Forest.

The pine butterfly can be considered a tree-killer as evident by the timber loss of these past epidemics: in 1893-96 approximately 1,500,000 acres of ponderosa pine were affected and from 20 to 90 percent of the stands were killed (Hopkins, 1907), in 1922-23 of the approximate 27,000 acres affected, 26 percent of the trees were killed (Evenden, 1940).

## OBJECTIVES

The objectives of this study were limited to a two-fold purpose:

1. To determine percent of mortality, and/or recovery, of ponderosa pine due to defoliation by the pine butterfly prior to control.

2. To determine the amount and value of loss of increment of ponderosa pine due to defoliation by pine butterfly.

The results of this study will be compared with those of the study conducted by Evenden (1940). The 1922-23 epidemic ran its course, finally being controlled by natural factors, namely Theronia atalantae (Poda.), while the 1953-54 epidemic was controlled at its peak by chemical spray.

## METHODS

Three hundred ponderosa pine trees were selected in 1953 within four areas on the Boise National Forest. Defoliation of trees was ocularly estimated and recorded, as well as their Keen class, d.b.h., and expected survival.

Five classes of defoliation were utilized: (1) less than 25 percent of old needles destroyed, (2) 25-50 percent, (3) 50-75 percent, (4) 75-90 percent, and (5) greater than 90 percent.

Table 1 shows the tree volume distribution by defoliation and tables 2a and 2b their distribution by Keen class.

Table 1. Distribution of sampled trees by area, defoliation, d.b.h. range and volume

| Area | No. of trees | D.B.H. range | No. and vol.(1000 bd.ft.) by defoliation class | | | | | | | | | | Total volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | <25% | | 25-50% | | 50-75% | | 75-90% | | >90% | | |
| | | | No. | Vol. | No. | Vol. | No. | Vol. | No. | Vol. | No. | Vol. | |
| Banner 1/ | 75 | 14-44 | 1 | .46 | 12 | 13.80 | 35 | 40.02 | 27 | 35.00 | 0 | 0 | 89.29 |
| Beaver 1/ | 75 | 16-44 | 0 | 0 | 10 | 12.08 | 27 | 40.92 | 37 | 48.73 | 1 | 0.13 | 101.86 |
| Owl-Lost | 50 | | 37 trees logged--area dropped from study | | | | | | | | | | |
| Swanholm | 75 | 14-48 | 2 | 3.36 | 6 | 10.05 | 32 | 36.95 | 33 | 49.92 | 2 | 1.38 | 101.66 |
| Totals | 225 | 14-48 | 3 | 3.82 | 28 | 35.93 | 94 | 117.89 | 97 | 133.65 | 3 | 1.51 | 292.81 |

1/ 25 of the original 100 trees were dropped from the study due to logging.

Table 2a. Distribution of the 1958 study trees within Keen's classes

| Area | Keen Class | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1A | 1B | 2A | 2B | 2C | 3B | 3C |
| Banner | 1 | | 2 | | | | 1 |
| Beaver | | 1 | | 2 | | 1 | |
| Swanholm | | 1 | | 1 | 2 | | |
| Total | 1 | 2 | 2 | 3 | 2 | 1 | 1 |

Table 2b. Distribution of all study trees within Keen classes

| Area | Keen Class 1 | | | | 2 | | | | 3 | | | | 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| Banner | 4 | | | | 6 | 7 | 5 | | 5 | 12 | 13 | | 4 | 8 | 11 | |
| Beaver | 2 | 2 | 1 | | 5 | 14 | 14 | | 6 | 11 | 10 | | 2 | 2 | 6 | |
| Swanholm | 3 | 7 | 1 | | 6 | 14 | 14 | 1 | 2 | 10 | 11 | | | 3 | 3 | |
| Totals | 9 | 9 | 2 | | 17 | 35 | 33 | 1 | 13 | 33 | 34 | | 6 | 13 | 20 | |

During October 1958, 15 trees were felled and discs cut according to the short cut sampling technique for growth analysis for separating external growth influences as reported by Stark and Cook (1957). One tree from each defoliation class per area was utilized; however, three of these trees were eliminated for statistical reasons. In brief, this method (referred to as the vertical sequence) is based on comparing years of growth from the pith. Two discs are removed from the tree: (1) the "base" disc is removed at an internode which will include the 10-year period prior to the defoliation, and (2) the "damaged" disc which will include the 5-year period prior to defoliation, the period of defoliation (in this case 1953) and the 5-year period after defoliation. The increment per year is then measured, the average of 4 radii, for both discs and plotted by corresponding year of formation from the pith. The base curve will show the normal growth and the damage curve the effect of defoliation. The two curves actually overlap for approximately half the study period, thus establishing the normal relationship. The magnitude can be determined by measuring the difference of these two curves, which should remain parallel if defoliation was of no effect.

The first step in testing this method for ponderosa pine was to plot the growth trend by year of ring formation (figure 1).

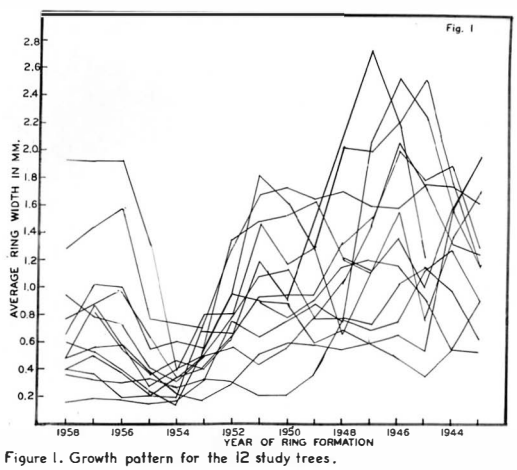


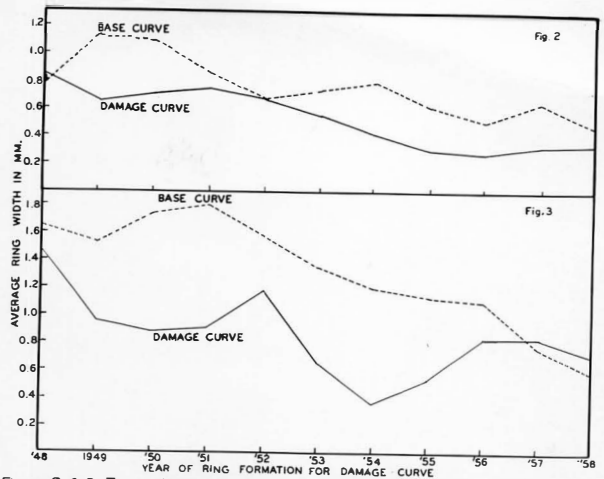
Figure 1. Growth pattern for the 12 study trees.

The growth trend of these twelve trees shows a certain amount of similarity or configuration. According to Duff and Nolan (1953): "Systematic factors or complexes operating to induce regularity in the distribution of growth activity which, however, is not the same under all circumstances but varies with variation in such conditions as site and stand density."

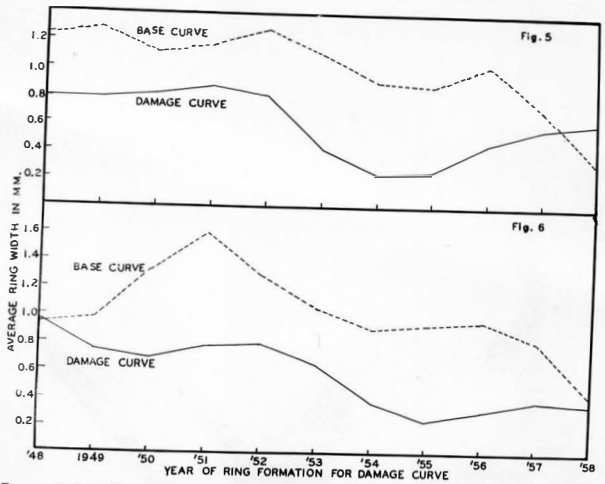
## RESULTS

Two-level growth sequence curves for the individual trees were first plotted and the results appeared to conform to the basic principles of the vertical sequence technique for separating external growth influences from inherent growth characteristics.

Graphs were then plotted for all trees within each defoliation class (figures 2 to 6). It appeared that less than 25 percent defoliation had no undue influence on the trees' growth, whereas the trees within the other classes of defoliation suffered some temporary loss of increment with the exception of the 50-75 percent defoliated trees. These trees show an apparent stimulated growth for the study period. Again, it might be well to mention that this infestation was controlled at its peak, thus allowing recovery and apparently no serious long-term loss developed. Had the infestation been allowed to continue, extensive tree mortality could very well have occurred.




Figures 2 & 3. Two-level growth sequences of ponderosa pine defoliated by the pine butterfly: Fig. 2 trees less than 25% defoliated. Fig. 3 trees 25-50% defoliated.




Figures 5 & 6. Two-level growth sequences of ponderosd pine defoliated by the pine butterfly: Fig. 5 trees 75-90% defoliated. Fig. 6 trees greater than 90% defoliated.

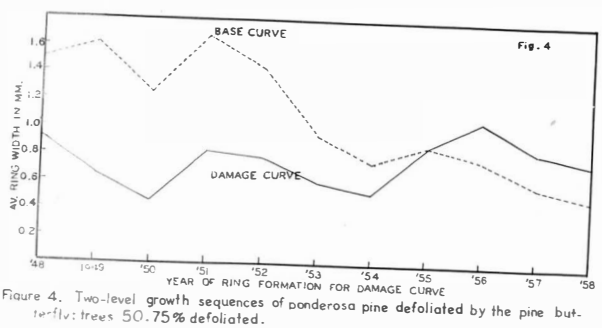
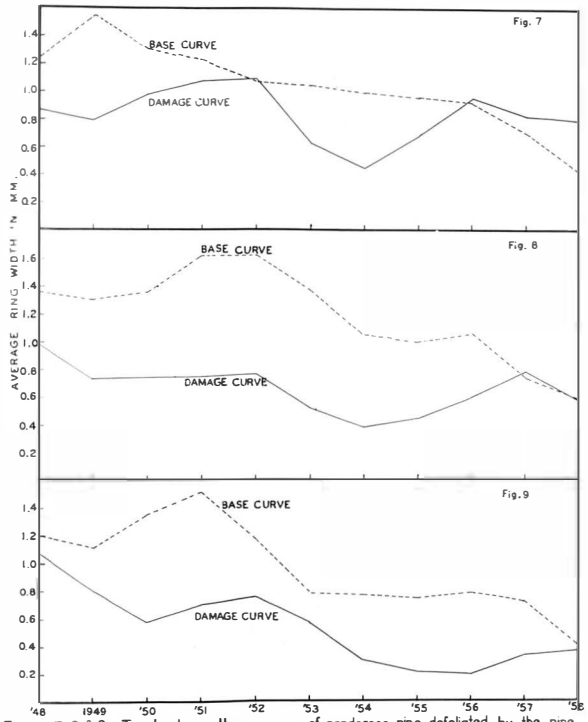



Figure 4. Two-level growth sequences of ponderosa pine defoliated by the pine butterfly: trees 50-75% defoliated.

Figures 7 to 9 were plotted by areas which show no apparent differences in growth loss or gain.




Figures 7, 8 & 9. Two-level growth sequences of ponderoso pine defoliated by the pine butterfly: Fig. 7 Bonner Road Area. Fig. 8 Beaver Creek Area. Fig. 9 Swanholm Area.

All trees, regardless of defoliation or area, were combined and plotted (figure 10). Again no great effect to growth due to defoliation is evident, with the exception that possibly growth was even stimulated.

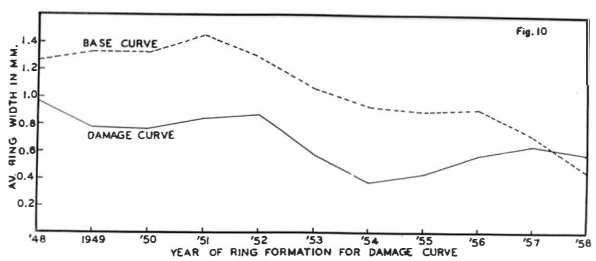
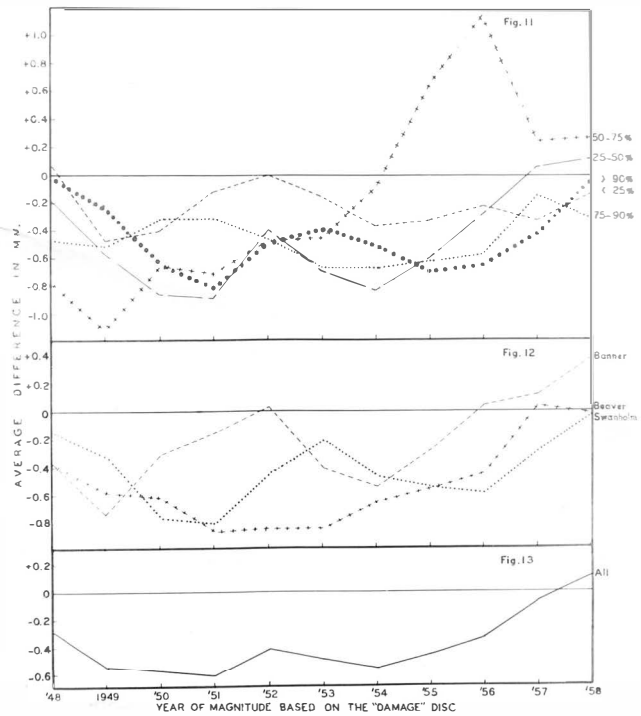



Figure 10. Two-level growth sequences of ponderosa pine defoliated by the pine butterfly: All study trees pooled.

Possibly a clearer method for showing these growth differences is by plotting their magnitudes. Figures 11 to 13 show such for defoliation classes, areas, and both combined. If the damage curve fell below the base curve the difference was of negative value; if above the base curve--a positive value. Again it is evident that an apparent stimulated growth occurred among the trees having been defoliated 50-75 percent (figure 11); no great differences in growth between areas, and a slight increase of growth in the overall picture.




Figures 11, 12 & 13. Magnitude of growth differences between base and damage curves: Fig. 11 Magnitude by Defoliation Class. Fig. 12 by Area. Fig. 13 All study trees pooled.

In order to compare growth periods; (1) 4 years prior to defoliation, (2) 3 years of defoliation, and (3) 4 years since the control, the algebraic average of the magnitudes was calculated for the respective periods (tables 3 and 4).

Table 3. Growth differences between periods based on the algebraic averages of magnitudes by defoliation classes

| Defoliation class | Year from pith | | | | | | | | | | | Loss or gain |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prior | | | | During | | | Post | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| <25% | +0.08 | -0.48 | -0.40 | -0.13 | -0.01 | -0.16 | -0.38 | -0.31 | -0.23 | -0.32 | -0.14 | |
| Alg. avg. | | -0.23 | | | | -0.18 | | | -0.25 | | | -0.02 |
| 25-50% | -0.17 | -0.37 | -0.86 | -0.89 | -0.40 | -0.70 | -0.84 | -0.60 | -0.28 | +0.06 | +0.12 | |
| Alg. avg. | | -0.62 | | | | -0.65 | | | -0.18 | | | +0.07 |
| 50-75% | -0.58 | -0.96 | -0.79 | -0.96 | -0.67 | -0.36 | -0.23 | -0.00 | +0.29 | +0.25 | +0.28 | |
| Alg. avg. | | -0.82 | | | | -0.42 | | | +0.21 | | | +1.03 |
| 75-90% | -0.46 | -0.51 | -0.31 | -0.31 | -0.48 | -0.68 | -0.67 | -0.62 | -0.58 | -0.14 | +0.31 | |
| Alg. avg. | | -0.40 | | | | -0.61 | | | -0.26 | | | -0.06 |
| >90% | +0.02 | -0.23 | -0.64 | -0.82 | -0.51 | -0.41 | -0.52 | -0.70 | -0.66 | -0.43 | -0.05 | |
| Alg. avg. | | -0.42 | | | | -0.48 | | | -0.46 | | | -0.04 |

Table 4. Growth differences between periods based on the algebraic averages of magnitudes by areas and overall picture

| Area | Year from pith | | | | | | | | | | | Loss or gain |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prior | | | | During | | | Post | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| Banner | -0.37 | -0.75 | -0.32 | -0.16 | +0.02 | -0.42 | -0.55 | -0.28 | +0.04 | +0.12 | +0.38 | |
| Alg. avg. | | -0.40 | | | | -0.32 | | | +0.07 | | | +0.47 |
| Beaver | -0.37 | -0.58 | -0.62 | -0.87 | -0.85 | -0.85 | -0.66 | -0.56 | -0.45 | +0.04 | -0.01 | |
| Alg. avg. | | -0.61 | | | | -0.79 | | | -0.25 | | | +0.36 |
| Swanholm | -0.13 | -0.31 | -0.77 | -0.81 | -0.43 | -0.21 | -0.47 | -0.55 | -0.59 | -0.39 | -0.03 | |
| Alg. avg. | | -0.51 | | | | -0.37 | | | -0.39 | | | +0.12 |
| All trees & areas | -0.29 | -0.55 | -0.56 | -0.61 | -0.42 | -0.49 | -0.56 | -0.46 | -0.34 | -0.07 | +0.12 | |
| Alg. avg. | | -0.50 | | | | -0.49 | | | -0.19 | | | +0.31 |

The loss or gain column is the cumulative algebraic difference of magnitude between periods of Prior vs. During and During vs. Post. The Prior period is used as base or average unaffected growth difference between base and damage curves.

It should be restated that these data are from only 12 trees and the inferences presented are preliminary and not conclusive. However, the apparent increase in growth will certainly be investigated more intensively in 1960.

Tree mortality has occurred since 1954, but only to a very small degree as compared to the 1922-23 epidemic (table 5).

Table 5. Comparison of tree mortality and causes between the 1922-23 and 1953-54 pine butterfly epidemics

| Epidemic | No. study years post-defol. | Number trees killed by | | | | | | Volume killed (1000 bd.ft.) | | Number study trees |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Defoliation | | Barkbeetles | | Total | | | | |
| | | No. | % | No. | % | No. | % | Amount | % | |
| 1922-23 (1940) | 11 | 12 | 12 | 14 | 14 | 26 | 26 | Not given | 36 | 100 |
| | 1st 4 | 5 | 5 | 13 | 13 | 18 | 18 | Not given | | 100 |
| 1953-54 | 4 | 0 | 0 | 2 | 0.89 | 2 | 0.89 | 0.64 | 0.22 | 225 |

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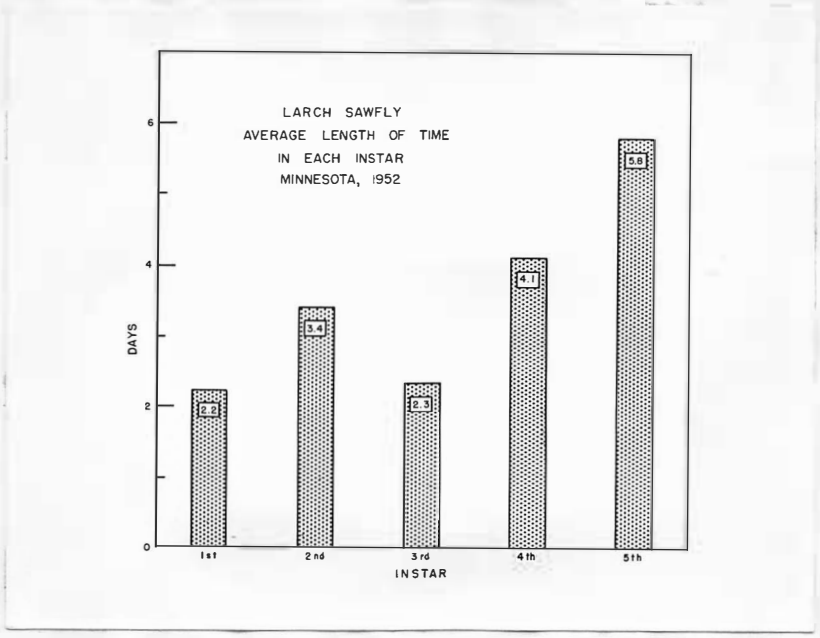


Figure 7. - Stadia periods for larch sawfly larvae under insectary conditions.

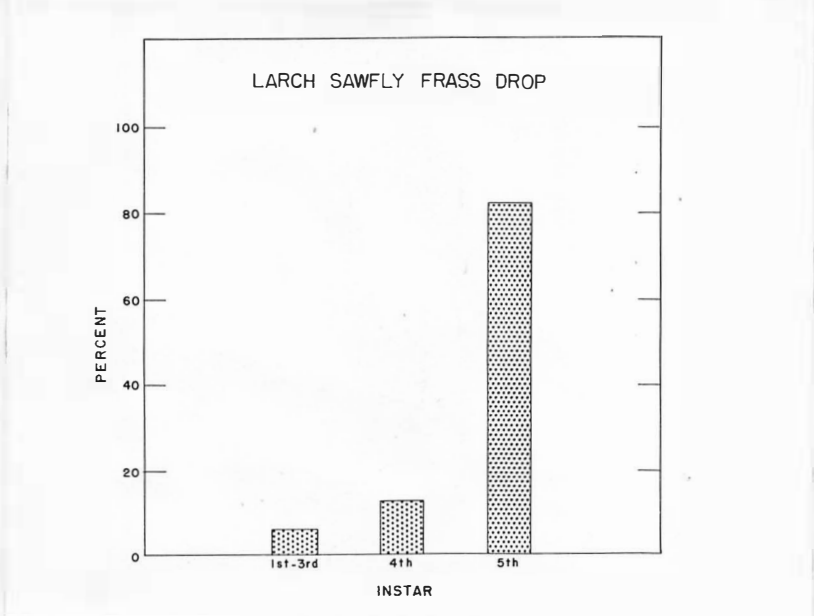


Figure 8. - Frass-drop of larvae (Fig. 7) based upon total O.D.W. of frass from larvae of the 5 instars.